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Relationships between Fluid Intelligence and Executive Functions*

In our recent study we investigated the relationship between fluid reasoning ability and prefrontal neocortex functions (spatial working memory and spatial planning). Fluid intelligence was assessed by using KABC-II test. Prefrontal neocortex functions were assessed by CANTAB computer test. Sixty normotypical Russian children (32 boys and 28 girls) participated in this study. Our results demonstrate, that two subtests which constitute the Fluid intelligence scale have different correlations with prefrontal functions. Main contribution to the relation between fluid reasoning and working memory was made by Story Completion subtest. Also, we found that there were no relations between fluid reasoning and spatial planning.

Keywords: fluid intelligence, spatial working memory, planning, KABC-II, CANTAB

Introduction. Relationship between fluid intelligence and Executive functions is one of the central problems for the studies of individual differences For the last ten years in cognitive science we can easily see an increasing number of studies, demonstrating the relationship between working memory and fluid intelligence [1–3]. Meanwhile other experimental works in this field do not support this point of view [4]. The objective of this work is to investigate the relation between fluid intelligence and Executive functions.

* The study was supported by the Russian Foundation for Basic Research, project № 18-013-01179.

Materials and Methods. A total sample of 60 Russian boys and girls, mean age 12,9, SD = 3,2 years was examined in the study. To assess fluid intelligence we used KABC-II. Fluid intelligence scale is based on two subtests: Story completion and Pattern reasoning subtests [5]. We used CANTAB to estimate executive functions: working memory (Spatial Working Memory test) and spatial planning ability (Stockings of Cambridge test). CANTAB-test is one of the most reliable behavioral methods for accessing Executive functions in the childhood. It has been demonstrated, that during the performance of this test prefrontal cortex is activated [6–7].

Results. A statistical analysis revealed evidence of relationship between score rate for the fluid intelligence index and success rate in the spatial working memory task (the number of errors received in the task) ($r = -0,33$ with $p < 0,05$), but not for success in spatial planning task. The Story Completion subtest makes a significant contribution to this relationship ($r = -0,33$, $p < 0,05$), but not the Pattern Reasoning subtest.

We decided to use regression analysis as the measure of relationship between fluid intelligence and various cognitive functions: short-term memory, long-term memory, planning function and working memory. As indicators of short-term working memory two subtests of KABC-II were chosen Number Recall and Word Order. We picked Atlantis and Rebus subtests of KABC-II as indicators of long-term memory were chosen. Also we used CANTAB-test to evaluate planning function and working memory.

Regression analysis revealed that both the Story Completion subtest and fluid intelligence scale have common significant predictor — the effectiveness of spatial working memory ($\beta = -0,34$; $p < 0,01$ for Story Completion; $\beta = -0,38$; $p < 0,01$ for fluid intelligence). However, there is no relation between subtest of Pattern Reasoning and working memory ratings, although this model has another significant predictor — ratings of Number Recall ($\beta = 0,49$; $p < 0,00$).

Conclusion. Our data demonstrates that different cognitive characteristics need to be used as significant predictors for two subtests, which constitute fluid intelligence scale in KABC–II test. Story Completion subtest revealed to have significant correlation with spatial working memory, while Pattern Reasoning subtest significantly correlates with

short term memory. Our results are in line with recent studies which discus how fluid intelligence and various types of memories are connected. Interestingly, our study illustrates that careful analysis of the components of fluid intelligence can resolve some contradictions that appeared over the years of research in this field.

1. *de Abreu P., Conway A., Gathercole S.* Working memory and fluid intelligence in young children // Intelligence. 2010. T. 38. № 6. P. 552–561.

2. *Johann V., Könen T., Karbach J.* The unique contribution of working memory, inhibition, cognitive flexibility, and intelligence to reading comprehension and reading speed // Child Neuropsychology. 2020. T. 26. № 3. P. 324–344.

3. *Rey-Mermet A., Gade M. et al.* Is executive control related to working memory capacity and fluid intelligence? // J. of Experimental Psychology: General. 2019. T. 148. № 8. P. 1335–1372.

4. *Conway A., Cowan N. et al.* A latent variable analysis of working memory capacity, short-term memory capacity, processing speed, and general fluid intelligence // Intelligence. 2002. T. 30. № 2. P. 163–183.

5. *Kaufman A., Kaufman N.* Kaufman Assessment Battery for Children. 2nd ed. Circle Pines, MN : Am. Guidance Service, 2004.

6. *Duncan J.* Frontal lobe function and general intelligence: why it matters // Cortex : A J. Devoted to the Study of the Nervous System and Behavior. 2005. T. 41. № 2. P. 215–217.

7. *Duncan J., Burgess P., Emslie H.* Fluid intelligence after frontal lobe lesions // Neuropsychologia. 1995. T. P. 261–268.